DOCUMENT RESUME

ED 343 807 SE 052 807

AUTHOR Webb, Norman L.; And Others
TITLE The Durham Mathematics Council Five-Year Site Report. Program Report 91-5 DU.
INSTITUTION Wisconsin Center for Education Research, Madison.
SPONS AGENCY Ford Foundation, New York, N.Y.
PUB DATE Dec 91
NOTE 49p.; For related documents, see ED 333 088-089, and SE 052 799-811.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS College School Cooperation; *Cooperative Programs; Educational Cooperation; *Faculty Development; Higher Education; Inservice Teacher Education; Intermediate Grades; Mathematics Education; Mathematics Instruction; *Mathematics Teachers; Middle Schools; Secondary Education; *Social Networks; *Teacher Role; Teacher Workshops; *Urban Education
IDENTIFIERS *Collaboratives; Durham City School District NC; Durham County School District NC; Urban Mathematics Collaborative Project

ABSTRACT

The Urban Mathematics Collaborative (UMC) project has the goal of contributing to the improvement of mathematics education in the inner-city schools by identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community including mathematicians from higher education and industry. This document is a 5-year site report on the Durham Mathematics Council from its inception in 1985 through June 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in the collaborative operated, the collaborative's management structure, and the focus of its activities. This final site report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total UMC project. (MDH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

SE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
A. Porter

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED343807

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

December 1991
Program Report 91-5 DU

THE DURHAM MATHEMATICS COUNCIL

FIVE-YEAR SITE REPORT

A Final Report to the Ford Foundation on the Urban Mathematics Collaborative (UMC) Project

Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, Allan J. Pitman, Edel M. Reilly, and James A. Middleton

Wisconsin Center for Education Research
School of Education, University of Wisconsin–Madison

SE053807

BEST COPY AVAILABLE

Program Report 91-5 DU

DURHAM MATHEMATICS COUNCIL
FIVE-YEAR SITE REPORT

A Final Report to the Ford Foundation
on the Urban Mathematics Collaborative (UMC) Project

Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg
Allan J. Pitman, Edel M. Reilly, and James A. Middleton

Report from the
Urban Mathematics Collaborative Documentation Project

Wisconsin Center for Education Research
School of Education
University of Wisconsin
Madison, Wisconsin

December 1991

We gratefully acknowledge the assistance of Margaret Powell, Kay Schultz, and Jeanne Connors in the preparation of this report.

The research reported in this paper was supported by the Ford Foundation and by the Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison. The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Ford Foundation or the Wisconsin Center for Education Research.

TABLE OF CONTENTS

		Page
I.	Introduction	1
II.	Five-Year Summary: 1985-1990	7
	A. Overview	8
	B. Purpose	9
	C. Context	10
	D. Management Structure	14
	E. Project Activities	17
	F. Reflections	32
References		43

I. INTRODUCTION

This document is a five-year Site Report on the Durham Mathematics Council, the urban mathematics collaborative that serves the Durham area, from its inception in 1985 through June, 1990. The intent of this report is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in which the collaborative operated, the collaborative's management structure, and the focus of its activities. It is not the intent of this report to review the development of the collaborative; this has been done in the annual reports. This final Site Report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals, as well as the goals of the total Urban Mathematics Collaborative project.

The Urban Mathematics Collaborative Project

In 1984, the Ford Foundation initiated the Urban Mathematics Collaborative (UMC) project to improve mathematics education in inner city schools and to identify new models for meeting the on-going professional needs of urban teachers. In February, 1985, the Foundation awarded five grants to establish urban mathematics collaboratives in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. In addition, the Ford Foundation established a Documentation Project at the University of Wisconsin-Madison to chronicle the development of the new collaboratives and a Technical Assistance Project (TAP) at the Education Development Center (EDC) in Newton, Massachusetts, to serve as a source of information for the collaborative projects (Romberg & Pitman, 1985). During the next 18 months, UMC projects were funded in Durham, Pittsburgh, San Diego, St. Louis, Memphis, and New Orleans, for a total of eleven collaboratives (Webb, Pittelman, Romberg, Pitman, Fadell, & Middleton, 1989). In August, 1987, an Outreach Project was funded at EDC to publicize and expand the UMC effort. In August of 1989, the Ford Foundation awarded replication grants to three additional sites: Dayton, Ohio; Columbus, Georgia; and Milwaukee, Wisconsin. In April, 1991, the fifteenth and final collaborative, the Greater Worcester Urban Mathematics Collaborative, was established in Massachusetts. A map indicating the location of UMC projects is presented in Figure 1.

The
Urban Mathematics Collaborative Project

Funded by The Ford Foundation

- **Cleveland Collaborative for Mathematics Education (C^2ME)**
  Cleveland, Ohio
- **Durham Collaborative: The Durham Mathematics Council**
  Durham, North Carolina
- **Los Angeles Urban Mathematics/Science/Technology Collaborative (LAUM/S/TC)**
  Los Angeles, California
- **Memphis Urban Mathematics Collaborative**
  Memphis, Tennessee
- **New Orleans Mathematics Collaborative (NOMC)**
  New Orleans, Louisiana
- **Philadelphia Math Science Collaborative**
  Philadelphia, Pennsylvania
- **Pittsburgh Mathematics Collaborative**
  Pittsburg, Pennsylvania
- **St. Louis Urban Mathematics Collaborative**
  St. Louis, Missouri
- **San Diego Urban Mathematics Collaborative**
  San Diego, California
- **San Francisco Mathematics Collaborative**
  San Francisco, California
- **Twin Cities Urban Mathematics Collaborative**
  Minneapolis-St. Paul, Minnesota

Replication Sites

- **Columbus Regional Mathematics Collaborative (CRMC)**
  Columbus, Georgia
- **Dayton-Montgomery County Public Education Fund Mathematics Collaborative**
  Dayton, Ohio
- **Greater Worcester Urban Mathematics Collaborative**
  Worcester, Massachusetts
- **Milwaukee Metropolitan Mathematics Collaborative (M^3C)**
  Milwaukee, Wisconsin

Figure 1. The National Network of Urban Mathematics Collaboratives.

During the five years covered in this Site Report, the climate of mathematics education in the United States has changed. When the Ford Foundation initiated the UMC project in 1984, a consolidated effort to reform mathematics had not yet begun, although the potential of the mathematics education community for achieving reform was envisioned. In this regard, the UMC project was innovative in mobilizing a group of inner-city teachers to increase both their sense of professionalism and their connections with mathematicians in the business community and in higher education. Between 1985 and 1990, the landscape of mathematics education in this country began to change dramatically. In an effort to develop a new mandate based on such studies as *Renewing United States Mathematics: Critical Resource for the Future* (Commission on Physical Sciences, Mathematics, and Resources, 1984) and *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education, 1983), the Mathematical Sciences Education Board in 1989 issued *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* and the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*. As the collaboratives matured, the movement to change mathematics education in the country took on momentum, creating a new environment for the collaborative network. What began as a project designed to enhance the professional development of urban teachers evolved into a catalyst for the reform of mathematics education.

At each site, the UMC project supports collaboration among school mathematics teachers and between teachers and mathematicians from institutions of higher education and industry; it also encourages teacher membership and participation in a broad-based local mathematics community. Although the guiding principle behind the UMC effort is that the teacher is and will remain at the hub of the educational process, it has become evident that many teachers--and especially those in inner-city schools--are overworked; lack support and material resources; and are isolated from their colleagues, from other professionals, and from the rapidly changing field of mathematics. Thus, the focus of the UMC project remains rooted in the premise that collegiality among professional mathematicians can reduce teachers' sense of isolation, enhance their professional enthusiasm, expose them to a vast array of new developments and trends in mathematics, and encourage innovation in classroom teaching.

Structure of the Five-Year Summary

The Five-Year Summary presented in the following chapter is comprised of six sections. The first section provides a brief overview of the collaborative. In the second section, the purpose of the collaborative is presented, as stated in its proposals to the Ford Foundation. The goals outlined in the collaborative's final request for funds to the Ford Foundation are contrasted with those specified in its initial proposal. The third section discusses the context within which the collaborative operated and the extent to which this has remained stable or has changed over the five-year period. Topics addressed in this section include demographic information on the surrounding community, changes in school district administration and enrollment and in the teacher population targeted by the collaborative, and significant changes occurring in mathematics and in the professional environment. The fourth section of the report describes the management structure adopted by the collaborative and changes that occurred in that structure over the five-year period. The fifth section covers the collaborative's activities in relation to four major themes that emerged as dominant in most collaboratives during the documentation process: socialization and networking, increased knowledge of mathematics content, teacher professionalism, and teacher leadership. These themes are used as a focus to organize ideas and to reflect on the collaborative's development with respect to some overriding expectations of the UMC project. The sixth and final section presents the reflections of Documentation Project staff on the approach the collaborative took to achieve its goals and the perceived outcomes in the areas of collaboration, professionalism, and mathematics focus.

The information presented in the Site Report is both a condensation and synthesis of information collected over the span of the UMC Documentation Project. Data were collected through monthly reports, the electronic network, four large-scale surveys, two demographic surveys, site visits, and case studies. These data-collection instruments and procedures are described in detail in the *UMC Guide to Documentation* (Pittelman, Webb, Fadell, Romberg, Pitman, & Sapienza, 1991). Detailed information about the Urban Mathematics Collaborative project is presented in six annual reports, four technical reports, and a set of case studies prepared by the Documentation Project. All of these reports are listed in the References. The Site Reports, which offer a retrospective summary of each collaborative's efforts over the grant period, have not been reviewed by

collaborative personnel and thus present the reflections solely of the Documentation Project staff.

II. FIVE-YEAR SUMMARY: 1985 TO 1990

A. Overview

The Durham mathematics collaborative, named the Durham Mathematics Council (DMC), was one of the first collaboratives to receive a grant from the Ford Foundation in 1985. The Durham Mathematics Council provides a contrast to the other collaboratives in several respects. The DMC, for example, is located in a metropolitan area of less than 200,000 and serves a smaller population than all of the other collaboratives, although the schools involved experience some of the same problems of high dropout rates, limited resources, and a high rate of poverty. The DMC serviced two school districts, the Durham City Schools and the Durham County Schools, which draw from populations of very different characteristics. Before the collaborative was formed, there was very little interchange between the two districts and essentially no interaction among the mathematics teachers from the two districts. Another contrast is that the DMC was hosted by the North Carolina School of Science and Mathematics (NCSSM)--the only collaborative to be operated out of a state-funded secondary school. The DMC Board of Directors, which includes representatives from business and higher education, was responsible for conducting the main business of the collaborative and attended to such matters as fund raising and long-range strategic planning. The DMC Board also differed from the governing boards of other collaboratives, which served more as advisory bodies to the collaborative administrators. The Director of the DMC operated behind the scenes helping to prepare the proposals and identifying people to serve on the Board. The Executive Director oversaw the operations of the collaborative and was the major force in recruiting teachers to participate. A Steering Committee, consisting of one teacher from each of the middle and secondary schools, met on a regular basis with the Executive Director to plan activities. The NCSSM provided office space for the collaborative, and a full-time secretary monitored the activities of the collaborative.

During the five years of the DMC's development, over two thirds of the approximately 140 mathematics teachers in the two districts participated in at least one DMC activity, while about 20 teachers were actively involved in collaborative events. The collaborative offered a varied program including dinner receptions, dinner meetings, a mathematics club, seminars at local businesses, subject area network groups, travel grants, mini-grants, a Resource Center, and a monthly newsletter. The collaboration that evolved

between teachers from the two districts served as a demonstration of how the two systems could work together. Merging the two districts became a prominent issue over the five-year period. Through the DMC, mathematics teachers felt more support from one another than in the past. The subject area networks provided opportunities for teachers to talk about specific courses and the use of new materials, and they became more knowledgeable about state activities through discussions with representatives from the North Carolina Department of Education. These events, along with attendance at national and state meetings where the new mathematics reforms were being discussed, gave at least some teachers increased confidence in themselves and greater knowledge about what was happening at both the state and national levels. The collaborative has also been a source of ideas for teachers. Teachers' interactions with one another, and the workshops and other professional development experiences made available to them through the collaborative, have stimulated teachers' thinking. Some teachers, funded by grants issued by the collaborative, worked during the summer to develop curriculum or prepare classroom materials. Through its Board and community activities, the DMC has drawn the community's attention to mathematics education. Although the collaborative has developed a structure that has reached a high percentage of Durham area mathematics teachers, it is very dependent on a few individuals to do the work that keeps it going. Such a structure, as has become evident, is fragile. However, it has provided in the past--and has the potential to do in the future--a means through which teachers and others in the community can join together to change how teachers view themselves and how mathematics is taught in Durham area schools.

B. Purpose

The initial proposal, approved by the Ford Foundation in August, 1985, identified five major areas for the professional growth of mathematics teachers: enhancement of knowledge of mathematics applications; expanding travel opportunities; growth as mathematicians; opportunities for collegiality; and professional self-esteem. This general statement of purpose for the Durham Mathematics Council was framed in terms of structuring certain conditions for the professional growth of teachers. The assumption was that if teachers increased their knowledge of mathematics, had access to travel, and developed a stronger relationship to a referenced group, they would mature within their field.

After its first year, the DMC reframed its purposes to focus less on changing conditions for teachers and more on encouraging teachers to change themselves. The proposal for refunding identified five themes to guide the development of the collaborative: empowering teachers to determine the mathematics curriculum; having teachers become involved in decision making; including teachers from the larger Research Triangle area; helping teachers to learn how to impact the state curriculum process; and reducing teacher isolation through the development of a professional mathematics community. These five themes were supported by more specific goals for the collaborative's Board of Directors: developing a secure resource base, involving teachers in decision-making, developing a broad-based network, and establishing community ownership for the Durham Mathematics Council. These purposes and goals guided the work of the DMC during its middle years.

At the end of four years, the Council submitted its final proposal to the Ford Foundation. In this proposal, the collaborative's purpose changed once again, reflecting a combination of the statement of purpose from the two previous proposals. The proposal specified that activities would be conducted at three levels: in-school activities, out-of-school activities, and networking activities. In-school activities were to be directed at supporting teachers. Out-of-school activities would include opportunities for teachers to change through motivation and empowerment. The networking activities included structuring links to others and educating non-teachers about needed changes in mathematics. The general guidelines specified that all activities were to be teacher-generated, flexible and innovative, and inclusive of all mathematics teachers.

The purposes stated in the first two proposals were drafted primarily by the collaborative director. The final proposal, although drafted by the director, was reviewed by teachers on the Steering Committee. The changes in purpose indicate an evolution in the DMC perspective on collaboration from trying to change teachers by structuring conditions for them to supporting and working with teachers and influencing others. The purposes stated in the final proposal also expressed a realization that influencing change required work at different levels as well as the differentiation of teachers' roles within school, outside of school, and with others. Another change noted is the growing prominence of mathematics education reform, with teachers providing the main thrust for reform. This is in marked contrast with a statement of purpose that focused only on providing professional opportunities for teachers.

C. Context

The Durham Mathematics Council exists in a growing metropolitan area that in 1989 had a population of approximately 180,000, an increase of 12 percent from 160,000 in 1985, when the collaborative was initiated. The city of Durham, with a population of 135,000, maintains both a government and school district that are separate from Durham County. Geographically, the two systems overlap with over half of the county schools within the Durham city limits. Economically, the Durham City Schools serve a population with a high rate of poverty, while the Durham County Schools serve a fairly affluent population. Although attempts have been made to merge the districts since the 1970s, the two school districts still maintain separate systems. In 1988-89, a new merger effort was initiated that included the formation of a task force to investigate the question and the possibility of holding another referendum. The Durham Mathematics Council serves mathematics teachers in middle and secondary schools from both school districts.

The Durham City Schools

From 1985 to 1990, student enrollment in Durham City Schools decreased 2 percent, from 8,400 to 8,200, continuing a pattern characterized by a decrease of 38 percent since 1970. In 1990, 1,948 students were enrolled in two high schools; 1,696 in 5 junior/middle schools; and 4,556 in 13 elementary schools. The student population has remained 93 to 95 percent black, 5 percent white, and about 1 percent from other ethnic groups. In the 1989-90 school year, 42 percent of all students came from families who received AFDC. The dropout rate for that school year was 12 percent, one of the highest in North Carolina. Three units of mathematics are required for high school graduation; Algebra I, Algebra II, and Geometry are required for an academic diploma. In 1988-89, 1,500 students, or 76 percent of Durham City Schools' high school students, were enrolled in mathematics courses.

The Durham City Board of Education has five elected members. In 1989-90, they oversaw 1989-90 district expenditures of $41.3 million: 51 percent were provided from state resources, 39 percent from local resources, 4 percent from federal funds, and 6 from other sources. When the collaborative was first formed, Dr. Cleveland Hammonds was the superintendent of the Durham City Schools. When he resigned at the end of the 1987-88

school year, Frank Weaver, an assistant superintendent, was appointed as interim superintendent until Dr. Hawthorne Faison was hired in April, 1989.

In 1989-90, the Durham City Schools employed 17 high school mathematics teachers and 24 middle/junior high school mathematics teachers. Sixty percent (25) of the mathematics teachers were female and 66 percent (27) were black. The number of high school mathematics teachers remained fairly constant over the five-year period, with 16 high school mathematics teachers employed in 1985. Of these, 15 majored in mathematics and one majored in mathematics education. Four of the teachers held master's degree in mathematics. They averaged 11 years experience in teaching high school mathematics, which was below the national average of 14 years.

There is no teachers' union in the Durham City or County districts. Teachers' salaries are determined by the state, but districts can choose to supplement that amount. In 1985, the 10-month salary range for North Carolina teachers was $15,500 (bachelor's degree and no experience) to $24,000 (master's degree and 29+ years of experience); by 1990, the range had increased from $19,810 to $38,910. In 1989-90, Durham City Schools teachers were given a local supplement of $400 to $2,000 and received 15 paid inservice days.

The North Carolina Department of Public Instruction issues a list of approved texts from which each local school district chooses a book that is used for each mathematics course throughout the district. The selection committees at the district level are comprised largely of teachers. The state compares public school systems by the performance of their students. The school systems' report card includes elementary students' reading and mathematics scores on the California Achievement Test (CAT) as well as their scores on the North Carolina tests for science, social studies, and writing. Comparisons among secondary schools include state examinations in algebra, biology, history, geometry, and chemistry. Scholastic Aptitude Test (SAT) scores and percentages of students passing state competency examinations in reading, mathematics, and writing are also used. The Durham City Schools operate a local summer school program, but receive funding and students from both school districts.

The Durham County Schools

The Durham County Schools provide a stark contrast to the city school system. The County schools, which draw students from an area of 275 square miles, reached an enrollment of 18,500 students in the 1989-90 school year, an increase of 2,000 students (14 percent) since 1984. In 1989-90, the district operated 24 schools--15 elementary schools, 5 middle/junior high schools, 3 senior high schools, and 1 special school. Two new elementary schools were opened at the beginning of the school year to relieve overcrowding. Although the student population continued to have a majority of white students, distribution by race shifted from 69 percent white, 29 percent black, and 1 percent from other minority groups in 1985 to 64 percent white, 33 percent black, and 3 percent from other minority groups in 1990. During 1989-90, the annual dropout rate was 7.5 percent and 14 percent of the student population received free or reduced-cost lunches.

Five elected members serve on the Durham County Board of Education. The 1990-91 school budget was approved at $111.6 million, an increase of approximately 2 percent from the 1989-90 budget of $109.2 million. State funds provided 61 percent of the budget, local funds provided 35 percent, and federal sources provided 4 percent. Durham County teachers receive a 10 percent annual supplement to the state salary, which is paid in December and May. Dr. Larry Coble was the superintendent of the Durham County Schools until spring of 1989 when he resigned and was succeeded by Dr. Jerry Weast.

In 1985, there were 35 high school mathematics teachers. All except one had a college major in mathematics or mathematics education and 12 had higher degrees in mathematics. Mathematics teachers had an average of 10 years of teaching experience. By 1989-90, the number of high school mathematics teachers had increased to 40, 78 percent of whom were white and 22 percent black. There were 46 County middle school mathematics teachers in 1989-90.

Approximately 80 percent of high school students in the Durham County Schools took mathematics courses in 1989-90. Graduation requirements at the time included two units of mathematics, to be increased to three in 1992. On the average, students take more than three mathematics courses during high school.

Professional Opportunities for Teachers

The Research Triangle area provides a variety of professional development experiences for teachers. The Durham Public Education Fund (DPEF), for example, an organization founded in 1985 to improve the quality of education in both the Durham City and Durham County Schools, began issuing grants to teachers in 1989-90. In 1990, DPEF received a grant from Mitsubishi Semiconductor America, Inc., to support teams of teachers interested in providing middle school students with field trips that would build on or extend the impact of classroom instruction. The Mathematics Science Education Network of the University of North Carolina and the North Carolina Department of Public Instruction sponsored a number of teacher inservice training programs, including a summer institute for mathematics and science teachers of Grades K-9. In 1989, the Semiconductor Research Competitiveness Foundation, along with IBM, DuPont, and the Microelectronics Center of North Carolina, sponsored Summer Project '89, a five-week summer program for teachers to encourage the establishment of an ongoing dialogue between the industrial community and secondary teachers.

The presence in Durham of the North Carolina School of Science and Mathematics (NCSSM), a state-funded residential high school for academically talented 11th- and 12th-grade students, has provided many special opportunities for teachers in the Durham area to be exposed to new ideas in mathematics and to increase their knowledge of mathematics. In 1986, for example, the NCSSM received a grant from the Carnegie Corporation to design a new course to replace precalculus in the curriculum. In July, 1987, with funding from the National Science Foundation, the NCSSM sponsored a national 12-day workshop which was attended by 38 UMC teachers, including several from the Durham area.

The State of North Carolina initiated a Basic Education Program in the mid-1980s that has doubled public school spending over the five-year interim to expand programs, add teachers, reduce class size, and increase teacher salaries. A merit pay system for teachers was piloted in 16 school systems during this period. One component of this program was the development of criteria for evaluating teachers, a controversial issue that was opposed by the North Carolina Association of Educators (NCAE), the largest teachers' organization in the state. Also associated with this movement to improve education in the state was the Department of Public Instruction's development of state examinations in algebra and geometry, among other content areas, to be administered at the end of the

school year in each class in these courses. Data from these exams would be one of several indicators used to make comparisons among secondary schools.

D. Management Structure

Plans for a mathematics collaborative in Durham were initiated in late January, 1985, when Barbara Scott Nelson of the Ford Foundation contacted Charles Eilber, the director of the North Carolina School of Science and Mathematics regarding the possibility. In late February of the same year, another meeting was held with representatives of the Ford Foundation and representatives of the NCSSM faculty and administration, the Durham City and County school districts, and the business and higher education communities. Great interest in the concept of collaboration was generated by the meeting and in ten weeks NCSSM submitted a proposal to the Ford Foundation.

The administrative structure of the DMC was defined in its initial proposal and, with only a few modifications, remained the same over the five-year period documented. The administrative talent of the collaborative was drawn from the staff of the NCSSM. Dr. Keith Brown, the Head of Outreach and Research at NCSSM, assumed the responsibilities of the collaborative director along with his responsibilities for the school. As the collaborative director, he oversaw fund raising, identified people to serve on the collaborative's Board of Directors, and served as the primary liaison with the Ford Foundation and with the UMC Technical Assistance and Documentation Projects. Dr. Jo Ann Lutz, the head of NCSSM's department of mathematics, served as the DMC executive director for three years, allocating one half of her time to this position and the other half to teaching and fulfilling her duties as department head. As executive director, Dr. Lutz was responsible for developing the collaborative's programming and for working with teachers. She spent a significant amount of time visiting the City and County schools and talking with mathematics teachers to encourage them to participate in the collaborative. In 1988-89, Dr. Helen Compton, a mathematics teacher at NCSSM and one of the initial planners for the collaborative, became the executive director. When Dr. Compton resigned in 1989, no one from NCSSM was able or willing to assume the position, so the collaborative conducted a community-wide search for an executive director. Vivian Leeper-Ford, a teacher at Durham City Hillside High School, assumed the half-time position as executive director while continuing to teach three classes. At the end of the

1989-90 school year, due to an unanticipated shortfall in the collaborative's budget, the collaborative was planning to consolidate the positions of project director and executive director.

Throughout the collaborative's existence, the NCSSM has provided office space for the collaborative administrators, as well as space for the DMC Resource Center. A full-time secretary, Barbara Davis, has worked for the collaborative from early in 1986. Ms. Davis helped develop the accounting system, edited the newsletter, arranged meetings and other events, contacted people, and assisted with publicity. The strong administrative support received from the NCSSM has provided the DMC with a continuity in leadership and stability not experienced by all of the collaboratives.

The organizational structure of the DMC consists of two principal bodies: the Board of Directors and the Steering Committee. The Board of Directors, the collaborative's governing body, develops policy for DMC, raises funds, and serves as the major decision-making group. Its membership, ranging from 16 to 18 members, is comprised of representatives from the administration of the two school districts, from NCSSM, and from the business and higher education communities, as well as one teacher from each district. The administrators of the collaborative report to the Board. As the collaborative has developed, the Board has become more prominent. In the beginning, the collaborative director strongly influenced the work of the Board. He identified people to serve on the Board and after the first year made adjustments in membership to draw people from the community who would meet the needs of the DMC. At the end of the five-year documentation period, the Board of Directors and its chair were dealing with issues critical to the livelihood of the collaborative--finances and administration. Board members have served as resources; several have sponsored collaborative functions at their companies and have attended some collaborative activities. The major work of the Board of Directors is carried out by five active committees. The Advisory Committee allocates collaborative funds to teachers who have submitted proposals for travel, grants, and mini-grants. The Finance Committee is responsible for developing a fund-raising strategy. The three other committees are the Public Relations, By-Laws, and Nominating Committees.

The Steering Committee, composed of at least one teacher representative from each of the 16 City and County middle and secondary high schools, is primarily responsible for guiding the DMC's program. The Steering Committee serves as a sounding board and

conduit for information between the teachers and the collaborative. Meetings of the Steering Committee were conducted by the executive director, who assured that there was one representative from each school to serve on the Steering Committee each year. The Steering Committee has fostered a strong bond among its teacher members, who have persuaded many of their professional peers to participate in DMC activities.

At the end of the five-year period, when the DMC was in its final Ford funding cycle, the collaborative was feeling the pressures of change. The director of the NCSSM changed in July, 1989, and with the new director came a change in the priorities of NCSSM. In March, 1990, Dr. Keith Brown left NCSSM to assume another position. At the same time, both school districts had new district superintendents. While coping with these changes, the DMC was also under pressure to attain financial security by raising funds and exploring a link with the Durham Education Fund. These changes forced the collaborative to rethink its relationship with NCSSM and with the two school districts and to consolidate the positions of collaborative director and executive director into a single position. In the summer of 1990, NCSSM was prepared to continue to house the collaborative and considered using it as a model for outreach to be implemented statewide. The new superintendent of the Durham County Schools, however, decided that the district's mathematics supervisor could provide a program comparable to the collaborative's and decided not to renew the district's pledge of $10,000 for 1990-91. The City superintendent, under budget constraints, also would not agree to provide the fixed amount of money that had been given to the DMC in previous years and instead decided to contribute what the district could. All of these factors contributed to a shaky future for the collaborative. Amidst these issues, the chair of the Board of Directors took the lead in finding solutions, one of which was arranging for Dr. Lutz to return as collaborative director in the fall of 1990.

The administrative structure of the DMC, stable in its earlier years, experienced some stresses and strains as time passed. That the collaborative director and executive director were faculty members of the North Carolina School of Science and Mathematics helped to give the collaborative stability and leadership. The Steering Committee provided access to and input from teachers. As the collaborative matured, the Board of Directors and its chair assumed a greater responsibility for resolving the issues that threatened the collaborative's existence. At the end of five years, the DMC, led by its Board of Directors, was adjusting its organization to exist with reduced funding, which will no

doubt impact on both the collaborative's program and its administrative structure as it sets its course into the future.

E. Project Activities

The Durham Mathematics Council offered a varied program of activities over the five-year period for the middle, junior high, and senior high school mathematics teachers in the Durham City and Durham County Schools. Initially, the collaborative planned its programming based on information from a teacher survey on which teachers indicated their degree of interest in a range of activities the Council was considering. As the collaborative matured, however, activities were more focused on topics that promoted reform in the mathematics curriculum.

The range of the Durham collaborative's activities addressed all four themes that had emerged from the documentation process as being dominant in collaborative programming. These themes were: Socialization and Networking, Increased Knowledge of Mathematics Content, Teacher Professionalism, and Teacher Leadership. Socialization and Networking activities, especially prominent in the formative years of the collaboratives, were designed primarily to initiate interaction among teachers and between teachers and mathematicians from business and higher education. These generally large-group activities were important to the evolution of the collaboratives since they brought members of the mathematics community together, enabled them to get to know one another, and promoted networking. The second theme, Increased Knowledge of Mathematics Content, encompassed activities designed to provide teachers with mathematics-directed experiences and increase the knowledge of teachers and others regarding current trends in mathematics and mathematics education. Many of these activities helped to activate the agenda of the mathematics reform movement at the collaborative sites. The third theme, Teacher Professionalism, involved activities structured to enhance teachers' conceptions of teaching as a profession. Collaboratives provided opportunities and incentives for teachers to attend professional organization meetings and made mathematics teachers aware of available grants and other opportunities for professional development. Some collaboratives paid teachers' dues for organization membership and arranged for teachers to observe other teachers and reflect on their teaching. The fourth theme, Teacher Leadership, had not been identified at the beginning of the UMC project, but gained greater attention as

collaboratives found that teachers lacked the skills needed to organize professional efforts, to plan, and to develop the power within their group to generate systemic change. This theme was advanced by the EDC through the UMC Teacher Leadership Workshops which, beginning in the summer of 1989, were attended by from one to four teachers from each of the collaboratives. However, since this training was initiated by EDC rather than by the collaboratives, it is not discussed in the reports of the individual collaborative.

In reflecting on collaborative activities as they related to the four themes, considerable overlap was noted, since most activities served multiple purposes. A single activity may, therefore, be discussed under several headings.

Socialization and Networking

One of the main goals of the Durham Mathematics Council is to provide opportunities for colleagueship with other teachers and local mathematicians. The collaborative planned a wide range of programs, including receptions, dinner meetings, subject area networks, and the Triangle Math Club, to draw teachers into cooperative, collegial relationships.

Receptions and Dinner Meetings

The Durham Mathematics Council sponsored nine receptions and three dinner meetings over the five-year period. These events were designed to provide an informal setting in which teachers and mathematicians from supporting institutions could meet and socialize. They also provided a forum for disseminating information about the collaborative.

The DMC sponsored an average of two receptions a year, including a reception each fall to "kick-off" the new school year. Three of the receptions were hosted by Glaxo Incorporated and held at the company's corporate headquarters at Research Triangle Park. In general, the receptions were well attended, with attendance averaging well over 50 and at one point reaching 90. At most receptions, there was good representation from members of the business and higher education communities.

With the exception of the September 1985 reception held to introduce teachers to the collaborative, the four other "kick-off" receptions featured presentations on topics related to mathematics, mathematics education, or teacher professionalism. At the December 1986 reception, Dr. Miriam Leiva of Davidson College spoke on "For the Love of Mathematics," addressing the issue of how to arouse the curiosity and spark the imagination of mathematics students. Dr. Henry Pollak, recently retired assistant vice-president at Bell Communications Research, Inc., spoke on, "From Fractions to New Frontiers," at the September 1987 reception, discussing how analysis of a simply stated problem can progress from grade school mathematics to the frontiers of research. The theme of the September 1, 1988 kick-off reception was Teacher Professionalism, and featured an address by high school teacher Gail Burrill, NCTM Board of Directors member, entitled "A Teacher As A Professional--The Challenge." The reception for the 1989 new school year included a presentation by Sarah Burke Berenson, director of the Center for Research in Mathematics and Science Education at North Carolina State University, on "A Model of Change for Implementing the NCTM *Standards*."

Two of the receptions, one in June, 1987, and one in December, 1988, were designated as Recognition Receptions and honored collaborative teachers. These are discussed later in the Activities section of the report, under the heading "Teacher Professionalism." A special reception was held in March, 1990, to welcome Dr. Arthur Powell of Rutgers University the evening before he was to present a collaborative workshop. At the reception, Dr. Powell spoke on "Equity, Writing to Learn Mathematics."

Between March, 1987, and April, 1990, DMC sponsored three dinner meetings. Each meeting featured an invited speaker who discussed a topic related to mathematics or mathematics education. The meetings also served as a forum for teachers to present the results of grant projects or to share information they had gained from having received funds to attend conferences and workshops. The March 1987 Dinner Meeting, which was attended by 42 people, featured a presentation by Steven Davis of the NCSSM on current trends in mathematics. Two DMC teachers also spoke on their experiences at the Exeter Computer Conference. The dinner meetings which the collaborative sponsored in March, 1988, and in April, 1990, addressed teacher professionalism and are discussed under that heading later in this report.

Triangle Math Club

The Triangle Math Club, an organization designed to draw mathematicians from all sectors and to promote the growth of mathematics and mathematics education, was formed during the 1986-87 school year. The Club provides an opportunity for all persons interested in mathematics from Durham and the surrounding Triangle area to meet in a social setting and to listen to and interact with one another and with invited speakers on various mathematical topics. While the Triangle Math Club is partially funded by the DMC in that clerical support and mailing are provided by the collaborative, most of its revenue is derived from $8 annual membership dues; these funds cover the cost of honoraria for speakers, as participants pay for their own dinners. Over the five-year period, the Triangle Math Club held nine dinner meetings; two during the 1986-87 school year, three during the 1987-88 school year, and four during the 1988-89 school year. The Triangle Math Club did not meet during 1989-90. Attendance at the meetings ranged from 16 to 44 and generally included a good representation of the business and higher education communities as well as teachers. The topics of the dinner presentations addressed a wide range of mathematical subjects, including "A Miscellany of Math Magic: A Number of Effects Based on Math and Logic with Applications," "Infinity--The Twilight Zone of Mathematics," "The Use of Statistics in Litigation," "The Birth of Biometry," "Numbers and Magnitudes: Some Historical Comments," "Mathematics in an Election Year," "Fractals, the Frontier of Mathematics," "The Historical Context of Mathematical Theorems: What You've Always Wanted to Know About the Cubic Formula and Were Afraid to Ask," and "Modeling Dynamic Systems using Stella Software." Among the participants at the dinner meeting at which the history of mathematical theorems was discussed were 21 teachers from 10 other UMC sites who were participating in an NSF program at NCSSM.

Subject Area Networks

Teacher-generated subject area networks were established to provide teachers of the same mathematics subject with opportunities to meet in small groups to discuss issues, share ideas, and to help one another with problems. Over the five-year period, the collaborative established six subject networks: the Algebra II/Precalculus Network during the 1985-86 school year, the Geometry Network during the 1986-87 school year, the

Middle School Mathematics Network during the 1987-88 school year, the Algebra I Network in the fall of 1987, and the Calculus Network and the Basics Network (a network formed to serve mathematics teachers who focus on non-algebraic skills, which included both middle school and high school teachers), both formed during the 1988-89 school year. Meetings of the networks were planned by participants and publicized through the DMC newsletter and special bulletins.

When initially established, the subject area networks served as important support vehicles, providing teachers with an opportunity to meet with other teachers to discuss topics directly related to the classes they were teaching. Meetings of the Algebra II/Precalculus Network, for example, featured demonstrations of appropriate software programs, discussions of business applications of mathematics, of probability and statistics, and a series of programs on the use of the Sharp EL-52000 Calculator. Meetings of the Geometry Network focused on new approaches to high school geometry, including ways that proof is being taught; hyperbolic geometry; pentominoes; and the State Department's end-of-course geometry test. Topics addressed at meetings of the Middle School Math Network included the district's reorganization from junior high to middle schools, making decimals meaningful, pre-algebra and algebra at the middle school level, mathematics assessment for the middle grades, mathematics competitions, and software evaluation. At the only meeting of the Algebra I Network that was held, teachers discussed the Algebra I Saxon textbook. Only two meetings were held of the Calculus and the Basic Networks. The first Calculus meeting addressed the Advanced Placement examination and the second focused on a review of software. Both meetings of the Basics Network focused on how to use computers and calculators to motivate students in solving problems and on a review of software.

When the first network was established, it was envisioned that the subject area networks would meet monthly after school, but teachers were not interested in participating that frequently. The strongest of the networks was the Algebra II/Precalculus Network, which met five times during the 1986-87 school year, seven times during 1987-88, five times during 1988-89, and four times during 1989-90. The Geometry Network, which got off to a slow start, met once during the 1986-87 school year, once during 1987-88, five times during 1988-89, and four times during 1989-90. The Middle School Mathematics Network met six times when it was established during 1987-88, and three times during 1988-89. The Algebra I Network met only once, when it

was formed in 1987-88, and then was disbanded. The Calculus and Basics Network met only twice.

In spite of the initial enthusiasm for the establishment of the subject area networks, by the end of the 1988-89 school year participation had diminished. Only four teachers had attended the meetings of the Basics Network and the second meeting of the Calculus Network, and only two teachers attended the final meeting of the Middle School Network in April, 1989. However, teachers seemed to maintain their interest in the Algebra II/Precalculus Network and the Geometry Network, with attendance ranging from 4 to 15.

In fall, 1989, the collaborative, for the first time, hosted a general meeting of all the networks to bring participating teachers together and to provide an opportunity to discuss end-of-year testing. Following the meeting, which only 19 teachers attended, the director decided to schedule regular meetings of only the two most popular networks, the Algebra II/Precalculus and Geometry Networks, and to schedule meetings for the other networks if the interest arose. Joint meetings of the two networks were held in February and March, and each met independently in both January and April. Overall, attendance was very poor, ranging from four teachers for the independent network meetings to eight teachers for the joint meetings of the two networks. Final meetings of each network were canceled when no one showed up.

Collaborative Newsletter

During the 1985-86 school year, the collaborative published three issues of a newsletter and, in the 1986-87 school year, increased the number of issues to approximately the publication of one every two months. During the 1989-90 school year, for example, the newsletter was published seven times. The newsletter, which is the DMC's primary tool for information dissemination, highlights upcoming activities, announces opportunities to receive funding for travel to conferences and workshops, provides articles on topics in mathematics and mathematics reform, and offers reports from DMC members and from the Council's executive director. In 1989-90, the newsletter, which was coordinated by the DMC secretary, averaged seven pages. The newsletter was mailed to the home of every secondary, middle, and junior high

mathematics teachers in the City and County school systems. In order to facilitate the exchange of ideas and information between teachers and others, the circulation of the newsletter was expanded during the 1988-89 school year to include nearly 375 people. Copies of the newsletters were sent to Steering Committee members for distribution to their building teachers and to mathematics users involved in DMC activities, donors, Board members, school principals, and district superintendents.

Increased Knowledge of Mathematics Content

The Durham Mathematics Council was committed to supporting opportunities for teachers' growth as mathematicians, as well as opportunities to enhance teachers' knowledge about local mathematics applications. In the earlier years, the collaborative's strategy was to offer a variety of programs to address a wide range of areas in the school mathematics curriculum and have teachers choose those that were of interest. The programs were primarily directed at improving specific teaching skills and at providing teachers with activities they could apply directly to the classroom. An overriding theme of the DMC program, especially in the latter years, was to focus on curriculum reform, with an emphasis on the use of technology. In addition to the subject area networks, which were discussed previously, collaborative programming to increase knowledge of mathematics content included a wide variety of workshops, seminars, and industry tours that were co-sponsored with area businesses and industries.

Workshops

Over the five-year period, the collaborative sponsored 14 workshops, varying in length from three hours to one week. Several of the workshops were scheduled during the school day, and substitute teachers were provided by the school districts as part of their contribution of up to 75 days of substitute coverage. In conjunction with four of the workshops, the collaborative was able to arrange for teachers to receive continuing education credit by participating in a follow-up session in which they shared classroom applications they developed in response to the workshop.

In general, the workshops addressed mathematics and its applications, as well as the teaching of mathematics, including the use of technology, statistics, data analysis, and manipulatives. Workshops were conducted by DMC teachers, as well as by representatives from higher education and the business communities. For some workshops, the collaborative brought in presenters who were high school teachers from other parts of the country. In 1986, three DMC teachers who had received grants to attend the Family Math Program in Berkeley, California, presented a workshop, in which five teachers participated, to share the ideas and information with the Durham junior high and middle school teachers. In June, 1986, the collaborative presented a two-day workshop on Probability and Statistics at the NCSSM that focused on topics to be used in the classroom or in helping students with research projects. Thirty-seven teachers participated in the program. The morning sessions were presented by NCSSM teachers, while the afternoon session was presented by Dr. Deborah Dawson, assistant professor of Biometry and Medical Informatics at Duke University Medical Center. In June, 1987, the collaborative sponsored a workshop on techniques for organizing a mathematics class and using instructional materials in a time-efficient manner. Nearly 70 people attended the presentation by David Johnson, the chairman of the Mathematics Department at a suburban Milwaukee High School and author of the books, *Every Minute Counts: Making Sense of Your Math Class Work* (1982) and *Making Minutes Count Even More* (1986). In May, 1990, IBM hosted an all-day session to introduce collaborative teachers to nine new mathematics education software programs and to provide them with an opportunity to use them. Twenty teachers participated in the workshop. Other topics addressed in workshops included "MATHCOUNTS"; the *Geometric Supposer* (Yerushalmy & Schwartz, 1985); "Mathematics in Applications"--providing meaningful courses to third-year mathematics students who are not ready for the algebra/precalculus track; EQTEC--a program to encourage females and minorities in mathematics and computer use; new calculator technology and how calculators will force changes in the way mathematics is taught; Contemporary Topics in Mathematics for Grades 7-12; TI-Math Explorer Calculator; Mathematics Manipulatives; IBM *Mathematics Exploration Toolkit*; and "Writing in the Mathematics Curriculum."

Seminars and Industry Tours

Over the five-year period, the Durham Mathematics Council sponsored a series of seminars and industry tours that were conducted in cooperation with area businesses and industries. For some seminars and tours, the collaborative scheduled a follow-up session to enable teachers to earn professional development credit.

Between November, 1985, and May, 1987, Durham teachers had an opportunity to participate in seven different seminars on the applications of mathematics to business research. Programs included: "Quantitative Risk Estimation" at the National Institute of Environmental Science; "The Importance of Mathematics" and "Principles and Techniques Involved in Managing Inventories of Materials, Supplies, and Finished Goods in a Consumer Products Manufacturing Company" at the Ligget & Myers Tobacco Company; "Health Economics Research, Actuarial and Underwriting Activities, and Information Systems" at Blue Cross-Blue Shield of North Carolina; "Statistics and Survey Research" and "The Applications of Mathematics and Computers to Research" at the Research Triangle Institute. Duke Power Company provided teachers with two-hour mini-sessions on the uses of applied mathematics.

Between March, 1986, and October, 1987, the collaborative sponsored four-day industry tours at local companies to provide teachers with an opportunity to observe the work being done by area companies and the applications of mathematics that were being used and to increase teachers' awareness of the mathematical needs of potential employees. Tours were held at General Telephone of the South; Duke Power Company's Physical Sciences Building, the Nuclear Training Facility, and the Explorium; at Lake Norman Power Plant hosted by Duke Power Company; and at IBM. From 7 to 25 teachers participated in the tours.

DMC Resource Center

In spring of 1987, the collaborative established a Teacher Resource Center at the NCSSM, next to the DMC Office. The Center, which is open on weekdays between 8 a.m. and 5 p.m., serves as an off-site workplace for teachers. It provides teachers access to computers, software, textbooks, a test bank, and other supplemental materials.

Teacher Professionalism

A major focus of the Durham Mathematics Council was to promote the professional growth of mathematics teachers. Two areas specifically identified in the DMC's initial proposal were to encourage the development of professional self-esteem and to increase travel opportunities. As the collaborative matured, it expanded its vision to help provide opportunities for teachers to effect change. The collaborative developed several programs directed at achieving these goals, including Teacher Recognition Receptions; dinner meetings to address issues of district, state, and national concern that affected the teaching profession; a national conference on Teacher Professionalism; and an extensive grant program that supported teacher attendance at conferences and workshops as well as opportunities for independent work and study. The collaborative also initiated an industry internship program in the summer of 1986, arranging two internship placements, but this program did not continue due to a lack of interest by the corporate sector.

Teacher Recognition Receptions

The Council sponsored two Recognition Receptions to honor collaborative teachers. The first Recognition Reception was held in June, 1987, at the North Carolina School of Science and Mathematics. Twenty-seven teachers received awards for their participation in programs funded by mini-grants and in conferences and workshops supported by the collaborative. Fifty-one people attended, including teachers, spouses, business representatives, a principal, and the mathematics coordinators from both school districts. The December 1988 Recognition Reception honored Wallie Green, a mathematics teacher at Jordan High School, as recipient of the 1988 Presidential Award for Mathematics in North Carolina. Forty-six people, including several representatives from business and higher education, attended the reception.

Dinner Meetings

Several of the Dinner Meetings sponsored by the Durham Mathematics Council provided teachers with an opportunity for input regarding district, state, and national

issues related to their profession. The March 1988 Dinner Meeting, for example, was designed to present DMC teachers with more information about the Career Ladder Program and the North Carolina Teacher Effectiveness Training Program, and to provide teachers an opportunity to voice their opinions on the Career Ladder Program before it was adopted by the school district. Registration for the dinner meeting was to be limited to the first 60 who responded, but interest was high, and ultimately, 62 persons, including 43 teachers, 8 school administrators, and several representatives from both the business and university communities attended. The April 1990 Dinner Meeting focused on a draft of the NCTM Professional Standards for Teaching Mathematics and offered teachers an opportunity to become familiar with and to critique an early version of the document. After the meeting, which was attended by only 14 people including 9 collaborative and 2 non-collaborative teachers, a summary of the discussion was sent to the chair of the NCTM Commission on Teaching Standards for School Mathematics.

Conference on Teacher Professionalism

On June 23-24, 1988, DMC, with support from NCSSM and the Education Development Center of Newton, Massachusetts, sponsored a conference on "Mathematics Reform and Teacher Professionalism" at NCSSM. More than 100 mathematics educators from 19 states attended the conference, which was designed to inform and guide the broader mathematics community in its effort to improve mathematics at the pre-college level. The purpose of the two-day event, which included presentations and discussions led by distinguished mathematicians and educators, was: (1) to review the recommendations for change by the National Council of Teachers of Mathematics and the Mathematical Sciences Education Board; (2) to explore the role of teachers as designers, critics, and consumers of a changing curriculum; (3) to consider local alliances as a vehicle for mathematics reform; and (4) to explore approaches to enriching the mathematics curriculum for all students. Twenty-two DMC teachers took advantage of the DMC's offer to pay the $125 registration fee for collaborative teachers who wanted to participate in the conference. A two-day follow-up meeting for conference participants was held in February, 1989. All DMC teachers were invited to participate in two of the sessions that were held during the meeting.

Mini-Grants, Travel Grants, and University and Independent Work Grants

The Durham Mathematics Council, which has made a strong commitment to supporting teachers in their participation in professional activities, initiated an extensive grant program in 1986 to provide funding for these activities. In 1988-89 alone, the collaborative allocated $21,000 for grants. While grant applications are still reviewed by the DMC Advisory Board, the guidelines for Requests for Funds were revised in 1990 to require teachers seeking financial support to submit a proposal for a professional development plan to the Advisory Board. The professional development plan, which must be created in consultation with the DMC executive director, lists both specific activities envisioned by the participant for the next twelve months and general professional objectives for the next four years. The collaborative provided clerical support to teachers to assist them in applying for collaborative grants as well as for grants offered by other organizations. Two DMC teachers, for example, received Bertelsman Foundation German-American Scholarships to go to Germany to work with mathematics teachers for four weeks during the summer of 1989, and another DMC teacher received a scholarship from the Woodrow Wilson National Fellowship Foundation to attend a Woodrow Wilson Institute in summer, 1989.

Mini-Grant Program. The DMC Mini-Grant Program was established to support innovative efforts to enrich and strengthen the mathematics curriculum in the Durham City and County Schools. Mini-grants provide seed money for instructional experimentation and equipment and for the development of new curriculum and materials. A teacher can apply for a mini-grant of up to $300, and special consideration is given to projects that involve more than one teacher and classroom to encourage teachers to work together. Between 1986 and 1990, nearly 50 mini-grants were awarded.

During 1986-87, five mini-grants were awarded which were used primarily to purchase video tapes on Management Science and Statistics and for curriculum development. In 1987-88, nine mini-grants totaling over $2,500 were made for the purchase of problem-solving materials, calculators, modems, software, printers, calculators, and students motivation materials. During the 1988-89 school year, 30 mini-grant proposals were received, of which 25 were awarded. The majority of requests sought funds to purchase classroom sets of the Texas Instrument Math Explorer Calculator which teachers had learned about at a DMC-sponsored presentation in January, 1988. In

1989-90, 10 grants totaling nearly $4,500 were awarded to 17 teachers. With the grants, teachers planned to purchase a Liquid Crystal Display Projection System, software, calculators, videos, the Middle Grades Mathematics Project materials, memory expansion cards, resource books, and manipulatives. In addition, one teacher used part of her grant to fund substitute days so she could attend a MATHCOUNTS workshop in Raleigh.

Travel Grants. The Durham Mathematics Council awarded significant funding to enable teachers to attend state and national meetings, to participate in workshops, and to visit schools with model programs. The travel grants were designed to provide teachers with the opportunity to be involved in the formulation and discussion of national issues in mathematics and mathematics education. In allocating the travel funds, the Advisory Board assigned highest priority to those programs that would enable teachers to bring back information to share with other teachers. In addition to transportation costs and registration fees, funds also were available to pay substitute teachers. Following a trip, participants were expected to submit written reports of their experiences and to give a presentation at one of the monthly teacher meetings, although this policy was not always strictly enforced. This policy was rescinded in 1989-90, because "reporting back" was not considered a requirement for most professionals. The DMC travel grants have had a clear impact on teachers' increased participation in professional conferences and meetings; using DMC funding, many teachers were able to attend a professional meeting or conference for the first time. A DMC teacher who attended a technology conference with DMC support published an article in the fall issue of *Consortium*.

Over the five-year period, the Durham Mathematics Council awarded over 130 travel grants: the collaborative awarded three in 1985-86; five in 1986-87; 51 in 1987-88; 45 in 1988-89; and 31, totaling over $10,000, in 1989-90. Among the meetings, conferences, and workshops teachers attended using DMC travel grants were: the 1986-90 Annual Meetings of the National Council of Teachers of Mathematics (NCTM); state meetings of the North Carolina Council of Teachers of Mathematics; regional meetings of the NCTM; the Carolina Mathematics Conference sponsored by the North and South Carolina Council of Teachers of Mathematics and the North Carolina Department of Public Instruction in Charlotte, North Carolina; the Family Math Instructors Training Workshop at the Lawrence Hall of Science in Berkeley, California; the 1986, 1987, 1989 and 1990 Conferences on Computers in Secondary School Mathematics at Phillips Exeter

Academy; the Microcomputers in Education Conference at Arizona State University; the 1989 and 1990 National Educational Computing Conferences; the North Carolina Educational Technology Conference in Greensboro; a five-day program, EQUALS in Computer Technology, at the University of California-Berkeley; an EQUALS Trainers Workshop at UMC-Chapel Hill; a two-week LOGO Workshop at the University of North Carolina; a two-day LOGO Conference in Arlington, Virginia; a statistics workshop at the NCSSM; the NSF-funded workshop on the precalculus curriculum at the NCSSM in July, 1987; a one-week workshop, Contemporary Topics in Precalculus Mathematics, at the NCSSM; the Advanced Placement Workshop in Durham; an Advanced Placement Institute at Wake Forest University in Winston-Salem, North Carolina; the Woodrow Wilson National Fellowship Foundation Institute on Mathematical Modeling in Columbus, Georgia; the Woodrow Wilson National Fellowship Foundation Geometry Institute at the NCSSM; the 1987 University of Chicago School Mathematics Project User's Conference in Chicago; and the conference, Making Mathematics Work for Minorities, in Atlanta.

Study Grants. The DMC offered grants for university study to provide mathematics teachers with the opportunity to pursue advanced study in mathematics. The collaborative provided teachers with a stipend for tuition, fees, books, and/or release time from one class. Over the five-year period, the collaborative awarded 12 study grants to teachers. In the summer of 1988, for example, three teachers received grants totaling $1,382; two of the teachers used the grants to take courses at the University of North Carolina-Chapel Hill, while the third teacher attended a summer institute at the University of North Carolina-Charlotte. In the summer of 1989, two teachers received grants totaling $850: one teacher received $350 for summer study at UNC-Chapel Hill, and the other received $500 to attend an Advanced Placement Workshop at UNC-Charlotte. In 1989-90, DMC awarded a $500 grant to a teacher to take a graduate course at the University of North Carolina-Chapel Hill.

Independent Work Grants

The collaborative awarded a small number of grants each year to provide teachers with up to one month's salary during the summer to pursue an area related to the goals of the collaborative, such as curriculum or materials development. These grants were awarded on a competitive basis. Beginning with the 1988-89 school year, special

consideration was given to projects aimed at groups that are traditionally underrepresented. Over the five-year period, 16 independent work grants were awarded. In 1986-87, three teachers received grants, ranging from $433 to $2,200 to develop curriculum materials over the summer; in 1987-88, the DMC awarded five teachers grants totaling nearly $7,500 for proposals to collect and develop mathematics games for middle school and to develop materials for the use of the Sharp EL-5200 Scientific Calculator; in 1988-89, six teachers received grants totaling nearly $10,000 to fund projects to purchase material to help prepare students for the SATs, to focus on curriculum development, to work on a computer programming course, and to develop a resource manual for geometry; in 1989-90, two awards totaling $2,800 were made to teachers to plan and prepare lessons and models to enhance critical thinking and to gather supplementary materials to enhance curriculum using the TI Math Explorer Calculator.

Teacher Leadership

The programming of the Durham Mathematics Council did not include a component that specifically addressed the development of teacher leadership. There was, however, some opportunity for teachers to have input at all levels of collaborative governance. The two teachers who have been members of the Board of Directors since its inception also sit on its Advisory Committee. Through the Steering Committee, teachers have an opportunity to offer suggestions for collaborative programming. As part of an effort to encourage the Steering Committee to assume more responsibility for developing and implementing activities, the collaborative sponsored a one-day planning retreat for the members of the Steering Committee in May, 1989. Thirteen teachers participated. A primary purpose of the retreat was to involve teachers in collaborative planning processes. At the retreat, the teachers generated a list of 18 goals which included raising professional standards, providing teachers with opportunities for collegiality, and empowering teachers to assume responsibility for their own professionalism. The teachers also generated programming suggestions for the collaborative, including speakers for a fall 1989 reception and topics for subject-area networks.

Various aspects of the collaborative's overall programming, including the dinner meetings, receptions, Triangle Math Club, seminars, the subject area networks, and the grant awards, have helped teachers learn more about mathematics, become current on the

latest trends, and interact with people who are prominent nationally. This has resulted in teachers becoming more self-confident and more willing to exert themselves to effect curriculum change. Teachers from Durham have begun to challenge some of the procedures that are followed by the state, including the operations of the state textbook selection committee. Teachers also confronted an administrator who wanted to introduce a third year of general mathematics and convinced him that a course involving higher-level mathematics would be preferable.

DMC teachers have also begun to accept responsibility for increasing the mathematics knowledge of their colleagues. Teachers who have participated in regional and national conferences have returned home to make presentations to their peers in order to share what they have learned. During 1988-89, for example, DMC teachers offered presentations to their colleagues from around the state at the Statistics and Data Analysis Workshop sponsored by NCSSM, and a DMC teacher teamed with a regional mathematics coordinator to present workshops on the Mathematics Manipulatives Kits. A DMC teacher made a presentation at the Helena, Montana, 1989 NCTM regional meeting. In January, 1990, the collaborative sponsored a "Show and Share" mini-conference. The activity, which was based on an idea that came out at the May 1989 retreat, was held to provide an opportunity for teachers who had received grants to attend conferences and workshops to share what they had learned with their colleagues. The half-day program, which featured concurrent workshops on seven different topics, was attended by 31 City and County teachers.

F. Reflections

The Durham Mathematics Council's development can be characterized as a series of adjustments, beginning with the change from the DMC's initial purpose of providing activities for the benefit of mathematics teachers to having teachers assume more responsibility for reform in the mathematics program. The composition of the Board of Directors was adjusted to include members who would be able to better meet the needs of the collaborative. The DMC's program was adjusted from being primarily menu-driven--teachers could pick and choose from a list of activities--to being more focused on curriculum change aligned with current mathematics reform efforts. There are, however, some major commitments that characterized DMC throughout its development. One is the

empowerment of teachers that has resulted from a reduction in their isolation from other teachers as well as from other users of mathematics. Another is the increase in knowledge of how mathematics is applied on the part of DMC mathematics teachers. A third is enabling Durham mathematics teachers to develop more global interests, becoming aware of issues at both the state and national levels.

The approach taken by the DMC was to create a structure operating out of the North Carolina School of Science and Mathematics, with strong ties to the larger Durham area community so that it could support efforts to empower mathematics teachers. From the DMC's inception, it was recognized that strong community support would be required for the long-term existence of the collaborative. The Board of Directors was formed with this in mind and provided the necessary link to business, higher education, and the school districts. Paralleling the development of community support, a program for teachers was developed that over the years became more focused on mathematics applications, technology, and curriculum reform. This program was balanced by providing networking activities to reduce the isolation among teachers and others; by providing travel grants and release time so that teachers could attend meetings and conferences to obtain new ideas; by providing grants for teachers to work over an extended period of time to translate ideas into materials; and by providing mini-grants for teachers to purchase needed materials that could not be obtained through the normal channels. The collaborative not only made it easier for teachers to learn about new advances and changes in mathematics education, but it also removed some of the obstacles for putting the ideas into practice. The collaborative program progressed over the years from attending mainly to local needs to turning outward to address state policy and national reform. The relatively small size of the target group made it possible for the executive director to give teachers individual attention and encouragement. This personal interaction had a major effect on getting teachers to participate in collaborative activities. Thus, the DMC was designed to garner community support in advancing the professional activities of mathematics teachers, to increase teacher's awareness of new ideas, and to provide teachers with a means for putting their ideas into practice.

The DMC has been successful in reaching about 70 percent of the approximately 140 middle school and secondary mathematics teachers in the Durham City and Durham County school districts. Of those who have participated, about 20 teachers have been extremely active, representing a percentage that is comparable to that in other

collaboratives. The approach taken by the DMC has generated community support to the degree that members of the Board of Directors have assumed a personal interest in raising the resources necessary to sustain the collaborative. The collaborative has reduced isolation among teachers to the extent that mathematics teachers from different schools have joined in cooperative efforts and discussions. The Triangle Math Club provided an opportunity for teachers and other mathematics users to meet with each other and to hear speakers, filling the void created by the lack of a professional organization in the area. The DMC strategy of offering a variety of grants has enabled teachers to use a travel grant to attend meetings to learn about new technology (such as calculators), and then to acquire calculators by submitting a mini-grant proposal to DMC. Teachers have reported making curriculum changes as a result of writing new curriculum materials in the summer supported through a DMC grant and then using the materials in the school year; they have introduced materials received at institutes, and incorporated ideas shared at network meetings. The DMC has been successful in exposing teachers to changes in the state education system and to recommendations for change at the national level by holding meetings at which state and nationally-known speakers have made presentations. The DMC has nurtured a good working relationship between the NCSSM and the Durham area mathematics teachers, thereby creating an interchange between NCSSM teachers and Durham teachers. At the end of five years, the DMC had made inroads in reaching mathematics teachers in the two districts, a number of whom have motivated their students in new ways.

The DMC has not done as well in developing leadership among the mathematics teachers and empowering them to become more involved in decision making. While a small core of about 20 teachers have assumed some responsibility for the advancement of the collaborative and their own professional growth, the majority of teachers have not. One indication of this was the collaborative's lost momentum in the fall of 1989, when there was a delay in appointing a director. The teachers essentially waited for an executive director to provide leadership, rather than continuing the program that had been outlined the previous spring by the Steering Committee under the former executive director. There is also a question of whether the two districts perceived the DMC as filling a unique role and whether they valued what the collaborative was doing. At the end of the five years, the Durham County Schools felt that they could provide mathematics teachers with the same programming that the collaborative was offering. This suggests that the new administration of the County Schools system did not see the

collaborative as contributing anything other than a standard professional development program. Furthermore, there has been no evidence that either district is using the collaborative model for other content areas. Among the major achievements of the DMC has been its capacity to reach and have an impact on individual teachers.

In retrospect, there were several opportunities to create leadership among the teachers that were not fully developed. In the early stages of the collaborative, the executive director set the agendas at meetings and made the arrangements for all collaborative programming. This is understandable--at the onset there is pressure to get the collaborative underway and it is easier for a single executive to do this than it is to mobilize a group of teachers to develop ideas. Also, at that time, teachers were not very clear as to what form of programming to offer. However, over the course of the collaborative's development, additional leadership positions for teachers could have been developed. A teacher, for example, might have chaired the Steering Committee and teachers could have formed a committee to address strategies for increasing the number of teacher participants.

Another challenge the DMC faced--one experienced by many of the other collaboratives--was that of reaching all of the targeted teachers. The collaborative was able to reach about 70 percent of the middle and secondary school mathematics teachers in both districts. There are many good reasons why teachers do not participate in collaborative activities. Having activities directed towards individuals, rather than groups, creates a situation where a teacher can easily choose not to attend. One strategy used by other collaboratives to reach more teachers was to direct activities toward the school mathematics departments; e.g., issuing departmental grants or having a collaborative presentation at departmental meetings. Focusing more on existing groups of teachers, such as a department, makes it more difficult for an individual teacher to avoid participating.

Another area that could have been further strengthened was the relationship between the collaborative and the districts' mathematics supervisors. A strong link was never established between the collaborative and district administrators who worked with the mathematics program. The difficulty the collaborative had in forming such relationships was exacerbated by the death of one of the district mathematics supervisors. But even prior to this, although the supervisors attended some activities and served on the Board of Directors, the work of the collaborative remained outside the work of the

districts' mathematics programs. As a consequence, when the Durham County Schools hired a new supervisor and a new superintendent, both felt that the district could do on its own what the collaborative was doing. There are, however, many reasons why it was difficult for the collaborative to form a strong relationship with the mathematics programs of the two districts. These included strong state control over the curriculum, the personalities of the individuals involved, and the districts' perception that NCSSM was removed from reality. In retrospect, perhaps someone from the collaborative could have involved the two district mathematics supervisors to a greater extent so that collaborative activities would complement district programs. Although the districts' mathematics offices were kept informed of collaborative programming, they were not integral to the process. While the collaborative was able to accomplish changes in individual teachers, it was less successful in effecting systemic changes in the operations of the districts' mathematics program.

Collaboration Outcomes

The Durham Mathematics Council has developed a number of forms of collaboration over its five years of existence. One form is the networking and sharing among teachers resulting from the diverse events scheduled for teachers, including the Show and Share Conference, and from Steering Committee meetings. A second form of collaboration involves using persons from business and higher education as resources for teachers in such programs as the IBM seminar and the workshops given by Arthur Powell. The activities of the Board of Directors represent a third form of collaboration, in which people from different groups were brought together to engage in decision making and planning. Unlike workshops and seminars in which higher education or business professionals provided information to teachers, everyone who attended the Board meetings participated on an equal level. A fourth form of collaboration involved the socialization across the sectors, which occurred at receptions or at social events such as the Kick-Off Reception. In the earlier years, the Triangle Math Club offered programs that functioned as interactive forums where people could associate with those from other sectors.

The variety in the forms of collaboration orchestrated by the DMC has resulted in multiple impacts on teachers. The most consistent outcome reported is the increased interaction among teachers, not only within a school but also across schools, within a

district, and across the two districts. Through this expanded reference group, teachers have gained new ideas for use in their classrooms and are more conscious of what other teachers are doing; thus, they have evolved a standard for their own teaching and are finding more opportunities to help other teachers. The workshops and seminars presented by representatives from business and higher education have increased teachers' knowledge of the use of technology in their classrooms and their awareness of the importance of having their students write more within the context of the mathematics classroom.

Collaborative teachers have a sense of being less isolated. This is a result of their becoming acquainted with other mathematics teachers and interacting with them as noted above, but it has also come about because they have greater access to the administration. A few of the teachers interviewed reported that their administrators, both at the school level and district level, are giving them more recognition. The fact that the districts provide release days for mathematics teachers is an example. That the idea of collaboration has not been adopted by the districts and used with teachers in other content areas surprised one member of the DMC Board of Directors who thinks that the idea of collaboration would benefit those in other areas beside mathematics. At least one principal has acknowledged the possibility; one teacher reported that her principal would like to see a collaborative in science, in history, and in English. She reports that the teachers in these content areas are jealous of the mathematics teachers. The principal's support of the mathematics collaborative was evident when he interviewed new teachers for the mathematics staff and encouraged them to become involved in the DMC.

A solid core of 15 to 20 teachers are very committed and active in the DMC. Many of them have a position of leadership, serving either on the Steering Committee or on the Board of Directors. Another 80 teachers have participated in collaborative programs by applying for and receiving grants or by attending one of the activities. Those teachers who have participated in the DMC speak highly of it and of the benefits they have gained from being more closely associated with fellow DMC teachers. However, the future of the DMC and the forms of collaboration it will promote seemed to be in question at the end of the 1989-90 school year, due in part to the reluctance of the mathematics teachers themselves to assert the kind of leadership needed to maintain the collaborative. Up to the present, teachers have depended on the executive director to get things done.

Professionalism Outcomes

The Durham Mathematics Council has had a significant impact on the professional development of mathematics teachers in the Durham area. Teachers have become more active and involved, attending workshops, conferences, and meetings; supporting each other through networking and cooperating on curriculum development; participating in programs that expose them to the latest trends in mathematics education and business; and assuming leadership positions in conducting workshops or chairing committees. Teachers who have participated in the DMC report that they have experienced increased self-esteem in response to being treated as professionals.

One effect of the collaborative on teacher participants has been that of increasing their confidence, enabling them to develop a new perception of themselves. Important to this change in self-image is the support teachers have gained from other teachers and from those in the community. One teacher reported participating in professional mathematics groups prior to her involvement in the collaborative, but not finding anyone to talk to about teaching mathematics. For her, the collaborative has increased her understanding of and her capacity for risk-taking, "I know I wouldn't have tried some things or understood them as well as I do now just because of having the meetings to go to [to] discuss them."

The collaborative has effected the development of leadership qualities in teachers. This can be attributed to an increase in self-confidence as a result of knowing more about mathematics, being more current on the latest trends, interacting with people who are prominent nationally, and receiving acknowledgement for teaching. One teacher reported that teachers affiliated with the DMC are perceived by administrators as being leaders. A teacher who had attended the UMC Teacher Leadership Workshop reported, "[The collaborative] has given me the opportunity to see myself through others' eyes and to discover how they perceive me. I find myself much more assertive in group discussions. The workshop on leadership at Boston helped me a great deal, particularly the sessions on active listening and networking. I have made productive attempts to implement these ideas and have found that they have changed my perception of myself as a leader."

In response to the 1990 Survey of Teacher Professionalism, mathematics teachers involved in the collaborative report that they feel a sense of dedication to work that they are universally convinced is of great value to the community. The majority of teachers

also believe that their work is not sufficiently valued by the community. This pessimism is less evident among those most active in the collaborative.

Almost all of the teachers responding to the Survey strongly support the view that they are teachers rather than mathematicians; this is particularly true for teachers who are only occasional participants in collaborative activities. However, all respondents recognized the importance of continued training in mathematics, as compared to the development of teaching and classroom management skills. Virtually all respondents are comfortable with and see the value of interactions with mathematicians and other users of mathematics, especially those teachers who have frequently attended collaborative activities.

While most of the teachers believe that they have sufficient control over day-to-day classroom decisions, those who were Frequent participants in the collaborative were less strong in their agreement on this. Level of collaborative involvement also related to teachers' views of occupational autonomy. Frequent participants in collaborative activities also tended to be more comfortable with peer review and with their colleagues' review of course content. A great majority hold strongly to the position that professional organizations should take responsibility for the setting of standards and for the implementation of reforms. This is particularly the case for those with greater involvement in the collaborative--a group which views professional organizations as relevant to the ordinary classroom teacher and which tends to attend meetings of professional organizations.

Teachers participating in the DMC have expressed the need to involve more mathematics teachers. However, there has not been much initiative shown by teachers in developing programs designed to increase involvement. Although active members of the Steering Committee did encourage other teachers from their school to participate, most of the responsibility for getting and keeping teachers involved falls on the executive director. In this sense, many Durham teachers have not taken the responsibility for building their own professional group.

Mathematics Focus Outcomes

The activities of the DMC touched on a wide range of areas in the school mathematics curriculum. The structure of the Council's program encouraged teachers to participate in workshops and seminars and then to write proposals to seek funding for the purchase of the innovative materials they were introduced to. Teachers had the opportunity to learn more about implementing the NCTM *Standards*, graphing calculators, data analysis, hands-on activities for geometry, statistics, using writing to reveal students' thinking, equity, working with the unprepared and unmotivated student, educational software, end-of-year testing, and Napoleon geometry. A range of topics has been addressed with special emphasis on the use of technology and the development of students' capacity to think. Teachers also learned more about how mathematics is being applied in businesses and industry. The Resource Center enabled teachers to borrow classroom sets of calculators, try new software, and preview supplementary materials. All of these experiences have given mathematics teachers new perspectives on their classroom teaching and on their professional relationships and development.

The experiences that the teachers have had through the DMC are making an impact on the mathematics curriculum. This is particularly significant for teachers in North Carolina because of the strong control exerted by the state over textbook requirements and end-of-year testing. A teacher who attended an institute on statistics with DMC funding added statistics to the Introduction to High School Mathematics course at her school. Other examples indicate that teachers have received ideas through collaborative activities that they have directly applied in their classes, such as the use of writing in mathematics. One teacher noted that he was having students do more hands-on activities that apply their knowledge because of what he has experienced through the DMC. This teacher explained, "I am trying to prepare [students] for the real world . . . give them floor plans of houses and let them plan houses. [These are] ideas I didn't have before, that I got from the Math Council."

Being associated with the North Carolina School of Science and Mathematics and its faculty of nationally-recognized teachers has been important to the DMC teachers. The association with the NCSSM, along with other factors, has helped to increase the teachers' sense of being well-informed and on the cutting edge of the education reform movement.

In responding to a question about how the collaborative has enhanced her professional life, a department head said, "I've met lots of math teachers and mathematicians. I've heard lots of speeches and have been to workshops. It has been a very exciting time, in math anyway. I'm very aware of all the literature coming out. I know people who write for national magazines. I have seen many of them on the School of Science and Mathematics campus, or at talks or workshops. I have been in seminars with them or sessions on mathematics connections. The collaborative has helped me realize that there has been a great explosion in the area of mathematics."

Teachers who have been active in the DMC have increased their awareness of what is happening in mathematics education. Teachers are using technology more and viewing the goals of teaching mathematics differently. Mathematically, the DMC has made a difference for at least some of the teachers in the Durham area in how they teach and, in some cases, what they teach.

Conclusions

The Durham Mathematics Council has had a positive impact on mathematics education in the Durham area. Teachers are much more aware of national trends, technology, and applications of mathematics than they were before the collaborative was established. Teachers from the two districts have gotten acquainted and have joined with persons from business and higher education to discuss mathematics and its applications. With no professional mathematics organization in the area, the DMC and the Triangle Math Club, which it helped to establish, filled a void. The DMC played a role in developing a relationship between the two school districts and the North Carolina School of Science and Mathematics. The NCSSM has provided leadership to the collaborative, giving it stability and linking it to other programs in the state and nation. The collaborative's association with the NCSSM has also drawn attention to it at the state level, with collaboration being considered a model for the professional development of teachers in other locations. While being hosted by the NCSSM has provided many beneficial outcomes, it has provided teachers with a difficult standard by which to co-exist.

The DMC has generated a group of community leaders who are advocates for mathematics education in the area. The greatest change for teachers has been in the

benefits they have received from joining together with their fellow mathematics teachers. Through this bonding, they have gained the support and the encouragement to try something new. Teachers, individually and in small groups, have made changes in what they teach and how they teach as a direct impact of their participation in the collaborative. The collaborative, however, has not been able to exert significant influence on the districts and their mathematics programs nor has it empowered teachers to take responsibility for planning and arranging activities for the collaborative. The DMC has formed a fragile network of very committed teachers and people from the community who value mathematics teachers and what they do. This network has helped to provide teachers with valuable opportunities. After five years, leadership is beginning to emerge among the teachers. It remains to be seen whether this leadership will be strong enough to enable teachers to become the organizers who will give the collaborative the strength it needs to survive.

REFERENCES

Commission on Physical Sciences, Mathematics, and Resources. (1984). Renewing United States mathematics: Critical resource for the future. Report of the ad hoc committee on resources for the mathematical sciences. Washington, DC: National Academy Press.

IBM. (1988). Mathematics Exploration Toolkit [Computer Software]. Developed for IBM by WICAT Systems, Inc.

Johnson, D. R. (1982). Every minute counts: Making sense of your math class work. Palo Alto, CA: D. Seymour Publications.

Johnson, D. R. (1986). Making minutes count even more. Palo Alto, CA: D. Seymour Publications.

Mathematical Sciences Education Board (MSEB). (1989). Everybody counts: A report to the nation on the future of mathematics education. Washington, DC: National Academy Press.

Middleton, J. A., Pitman, A. J., Webb, N. L., Romberg, T. A., & Pittelman, S. D. (1991). Mathematics teachers' views about teaching as a profession: Final results of a four-year longitudinal study (Report from the UMC Documentation Project). Madison, WI: University of Wisconsin-Madison, Wisconsin Center for Education Research.

Middleton, J. A., Webb, N. L., Romberg, T. A., & Pittelman, S. D. (1990). Teachers' conceptions of mathematics and mathematics education (Report from the UMC Documentation Project). Madison, WI: University of Wisconsin-Madison, Wisconsin Center for Education Research.

Middleton, J. A., Webb, N. L., Romberg, T. A., Pittelman, S. D., Richgels, G. M., Pitman, A. J., & Fadell, E. M. (1989). Characteristics and attitudes of frequent participants in the Urban Mathematics Collaboratives: Results of the Secondary Mathematics Teacher Questionnaire (Report from the UMC Documentation Project). Madison, WI: University of Wisconsin-Madison, Wisconsin Center for Education Research.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Washington, DC: U.S. Department of Education.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: Author.

Pittelman, S. D., Webb, N. L., Fadell, E. M., Romberg, T. A., Pitman, A. J., & Sapienza, M. (1991). The UMC guide to documentation. Madison, WI: Wisconsin Center for Education Research.

Popkewitz, T. S., & Myrdal, S. (1991). Case studies of the Urban Mathematics Collaborative Project: A report to the Ford Foundation. Madison, WI: University of Wisconsin-Madison, Wisconsin Center for Education Research.

Romberg, T. A., & Pitman, A. J. (1985). Annual report to the Ford Foundation: The Urban Mathematics Collaborative Projects (Program Report 86-1). Madison, WI: Wisconsin Center for Education Research.

Romberg, T. A., Pitman, A. J., Pittelman, S. D., Webb, N. L., Fadell, E. M., & Middleton, J. A. (1988). Mathematics teachers' views about teaching as a profession: An initial assessment (Report from the UMC Documentation Project). Madison, WI: University of Wisconsin-Madison, Wisconsin Center for Education Research.

Romberg, T. A., Webb, N. L., Pitman, A. J., & Pittelman, S. D. (1987). 1986 Annual report to the Ford Foundation: The Urban Mathematics Collaborative Project

Webb, N. L., Pittelman, S. D., Romberg, T. A., Pitman, A. J., Fadell, E. M., & Middleton, J. A. (1989). The Urban Mathematics Collaborative Project: Report to the Ford Foundation on the 1987-88 school year (Program Report 89-1). Madison, WI: Wisconsin Center for Education Research.

Webb, N. L., Pittelman, S. D., Romberg, T. A., Pitman, A. J., Middleton, J. A., Fadell, E. M., & Sapienza, M. (1990). The Urban Mathematics Collaborative Project: Report to the Ford Foundation on the 1988-89 school year (Program Report 90-1). Madison, WI: Wisconsin Center for Education Research.

Webb, N. L., Pittelman, S. D., Romberg, T. A., Pitman, A. J., & Williams, S. R. (1988). The Urban Mathematics Collaborative project: Report to the Ford Foundation on the 1986-87 school year (Program Report 88-1). Madison, WI: Wisconsin Center for Education Research.

Webb, N. L., Pittelman, S. D., Sapienza, M., Romberg, T. A., Pitman, A. J., & Middleton, J. A. (1991). The Urban Mathematics Collaborative Project: Report to the Ford Foundation on the 1989-90 school year (Program Report 91-1). Madison, WI: Wisconsin Center for Education Research.

Yerushalmy, M., & Schwartz, J. (1985). Geometric Supposer [Computer Software]. Developed by Educational Development Center, Inc. Pleasantville, NY: Sunburst Communications.